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Adelphacme (Loganiaceae), a new genus from south-western Australia

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Abstract

The new genus *Adelphacme* (Loganiaceae) is here described. *Adelphacme* is placed in Loganieae and is distinguished from all other genera in Loganiaceae by the following unique combination of characters: stipules reduced to a persistent, membranous, interfoliar sheath; 5-merous calyx, corolla and androecium; calyx with indistinct tube; corolla glabrous or papillose with valvate aestivation; ovary semi-inferior and capsule two-horned (mitre-shaped) with styles persistent and apically united. The new combination *Adelphacme minima* (B.J.Conn) K.L.Gibbons, B.J.Conn & M.J.Henwood is here made. A key to the seven genera of Loganieae, recognised here, is provided. The key is modified to include all Australian genera of the family Loganiaceae.

Introduction

Generic and infrageneric boundaries and phylogenetic relationships in Loganieae (Loganiaceae) have recently been evaluated using nucleotide sequence data (Gibbons et al. 2012). In that study, the south-western Australian endemic *Mitreola minima* B.J.Conn was not placed with other species of *Mitreola* L. Instead, *M. minima* was resolved as sister to *Mitrasacme* Labill., *Phyllangium* Dunlop and *Schizacme* Dunlop, thereby rendering *Mitreola* polyphyletic (Gibbons et al. 2012, Fig. 1). Morphological evidence supports this relationship and the recognition of the taxon '*Mitreola minima*' as a species of a new, monotypic genus.

In describing the new species *Mitreola minima*, Conn (1996) placed it in *Mitreola* based on its incompletely dichasial inflorescences, 5-merous calyx, corolla and androecium, slightly semi-inferior ovary and mitre-shaped capsules. *Mitreola* is largely distributed in the Americas, Asia and Madagascar, with one widespread species, *M. petiolata* (J.F.Gmel.) Torr. & A.Gray, also present in Africa, New Guinea and northern Australia. This new species, endemic to south-western Australia, was geographically isolated from the remainder of *Mitreola*, and its biogeographical history was puzzling. We are now able to evaluate the morphological characters used to support the generic placement of *M. minima* in a phylogenetic context (Gibbons et al. 2012). It appears that these morphological characters (listed above) are plesiomorphic or homoplastic within Loganieae, with incompletely dichasial inflorescences and 5-merous flowers also being widespread throughout the Loganiaceae. This paper formally establishes the new genus *Adelphacme* K.L.Gibbons, B.J.Conn & M.J.Henwood, with affinities to the Australasian genera *Mitrasacme*, *Phyllangium* and *Schizacme*.

Loganieae is one of four tribes remaining in Loganiaceae after re-circumscription of the family by Backlund et al. (2000). Following that study, Loganieae was expanded to include *Mitreola*, *Mitrasacme* and its segregates *Phyllangium* and *Schizacme*, previously placed in Spigelieae (Struwe 2004, Heywood et al. 2007). This classification, which placed these genera together with *Logania* R.Br. and *Geniostoma* J.R.Forst. & G.Forst. (including *Labordia* Gaudich.), has received further support in subsequent studies (Frasier 2008, Gibbons et al. 2012).

Loganieae is one of three tribes in Loganiaceae with dehiscent capsular fruits. Antonieae possess winged or spindle-shaped seeds and septicidal capsules (sometimes also splitting loculicidally for a short distance from the apex), and are further distinguished by aspects of their wood anatomy (Leeuwenberg & Leenhouts 1980, Mennega 1980, Backlund et al. 2000, Grant 2009). Spigelieae, now including only *Spigelia* L., is readily distinguished by its strongly bilobed capsules with persistent style bases (the upper portion of the style being deciduous) and generally cincinnate inflorescences (Leeuwenberg & Leenhouts 1980, Popovkin 2011). Capsule dehiscence in *Spigelia* is both loculicidal and septicidal, thus producing four deciduous valves from a bicarpelate gynoecium, with a distinctive basal cupula persisting within the calyx following shedding of the valves (Leeuwenberg & Leenhouts 1980). Strychneae are distinguished by their fleshy indehiscent fruits, although molecular evidence does not support the monophyly of the tribe as currently circumscribed (Backlund et al. 2000, Frasier 2008).

Finding morphological synapomorphies for an expanded Loganieae is somewhat more difficult, but they appear to lack the alkaloids and aluminium accumulation found in the rest of the family (Bisset 1980, Backlund et al. 2000). The tribe contains all genera of Loganiaceae with (variously) imbricate corolla aestivation, but also several genera or species with valvate corolla aestivation. *Mitrasacme* and *Mitreola* share mitre-shaped, semi-apocarpous capsules, and a close association between these genera has long been inferred (Bentham 1857, Leenhouts 1962, Leeuwenberg 1974). Backlund et al. (2000) suggested that early basipetal dehiscence found elsewhere in the tribe might be homologous with semi-apocarpy, which might then provide a morphological synapomorphy for the tribe. In the analysis of Gibbons et al. (2012), *Mitreola* was not placed sister to *Mitrasacme* and its segregates, but was instead sister to the remainder of Loganieae. It appears, then, that semi-apocarpy is not simply synapomorphic in these genera, but has either evolved in parallel, or has been secondarily lost several times within the tribe.

Taxonomic treatment

Adelphacme K.L.Gibbons, B.J.Conn & M.J.Henwood, ***gen. nov.***

Type species: *Adelphacme minima* (B.J.Conn) K.L.Gibbons, B.J.Conn & M.J.Henwood

Annual herb. *Leaves* decussate, rarely in whorls of 3, sessile; stipules persistent, membranous, reduced to interfoliar obtriangular sheath. *Inflorescence* terminal; uniflorescences incompletely dichasial. *Flowers* with calyx, corolla and androecium 5-merous; corolla lobes valvate; stamens epipetalous; ovary semi-inferior, 2-locular; placentation axile, hemispherical; styles 2, united apically at anthesis and in fruit. *Capsule* 2-horned.

Etymology: the name *Adelphacme* has been formed from the Greek ἀδελφή (*adelphe*), meaning sister, and although ἀκμη (*acme*) means highest point, the '*acme*' is here used in reference to the sister-relationship of *Adelphacme* with *Mitrasacme* and *Schizacme*.

Note: in the protologue of *Mitrasacme*, Labillardière (1804) equates ἀκμη with the Latin *flos* (flower), and states the etymology is in reference to the flower having the form of a mitre. The gynoecium of the type species, *Mitrasacme pilosa* Labill., is distinctly mitre-shaped and can be easily seen without dissection, the corolla being shallowly campanulate. Later authors have assumed the etymology of *Mitrasacme* refers to the shape of the capsule (Don 1837; Leeuwenberg & Leenhouts 1980; Dunlop 1996a, c). 'Highest point' and 'flower' are essentially variations of the same meaning of ἀκμη (which can also include prime and zenith), because the flower may be considered to be the 'highest point' in the lifecycle of the plant (Liddell & Scott 1940).

Adelphacme minima (B.J.Conn) K.L.Gibbons, B.J.Conn & M.J.Henwood, ***comb. nov.***

Basionym: *Mitreola minima* B.J.Conn *Kew Bulletin* 51: 169–173, Fig. 1 (1996)

Type: Western Australia: Darling (Warren): 1.8 km S along Middle Road from Boronia Road, headwaters of the Bow River, NE of Walpole, *T.D. Macfarlane 2297 & A.R. Annels*, 2 Nov 1994 (holo: PERTH4179323; iso: DNA, K, NSW366873).

Informal names: *Mitrasacme* sp. South West (*G.J. Keighery 343 n.v.*); *Mitreola* sp. Woolbernup Hill (*K.R. Newbey*

11066) (FloraBase 1998+)

Distribution: known from the Darling and Eyre regions of the South-West Botanical Province, Western Australia, from Bunbury in the north to Ravensthorpe in the east.

Conservation status: Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora Priority Three: Poorly-known taxa.

Other specimens examined: Western Australia: Darling: 2.3 km S along Middle Road from Boronia Road, NE of Walpole, *Macfarlane 2298 & Annels*, 2 Nov 1994 (NSW, PERTH); 1.8 km S along Middle Road from Boronia Road, NE of Walpole, *Annels & Hearn s.n.*, 21 Nov 1994 (CANB, DNA, NSW366874, PERTH); W of South West Highway, *Bennett s.n.*, 9 Nov 2007 (PERTH07980922; photograph!); Eyre: Fitzgerald River National Park: 7 km NNE Woolbernup Hill, *Newby 11066*, 21 Nov 1985 (DNA, NSW, PERTH).

Key to the genera of Loganiaceae tribe Loganieae

Note: *Labordia* is not included in the following key. A recent molecular phylogenetic study (Gibbons et al. 2012) found that at least some species of *Labordia* should be reduced to synonymy of *Geniostoma*. Sampling was limited to three of the 17 species of *Labordia* and did not include the type species, *L. fagraeoidea* Gaud. A more complete phylogenetic evaluation of the status of all species of *Labordia* is required. Should the continued recognition of a reduced *Labordia* be warranted, the morphological characters separating *Labordia* and *Geniostoma* will require reassessment.

1. Herbs or subshrubs 2
1: Shrubs, trees or woody climbers 7
2. Capsule two-horned (horns occasionally adherent along almost their entire length, appearing continuous with base of styles) or bilobed 3
2: Capsule without horns, not bilobed; Australia (not Tasmania), doubtfully New Zealand (extinct) ..... ***Logania***
3. Calyx, corolla and androecium 4-merous, or calyx absent 4
3: Calyx, corolla and androecium 5-merous 6
4. Calyx absent; corolla and capsule enclosed in a two-lobed foliaceous involucre; ovary semi-inferior; southern Australia (including Tasmania) ..... ***Phyllangium***
4: Calyx present, involucre absent; ovary superior 5
5. Calyx tube indistinct, up to 1 mm long; calyx lobes generally unequal; capsule laterally compressed, appearing broadly cuneiform in lateral view; placenta elongate, seeds few; Australia (Tasmania and alpine Victoria) and New Zealand[1] ..... ***Schizacme***
5: Calyx tube distinct; calyx lobes equal; capsule generally globular, ovoid or ellipsoid; placenta hemispherical, seeds many; northern and eastern Australia (including Tasmania), New Caledonia, New Guinea, Southeast and East Asia ..... ***Mitrasacme***
6. Leaves <4 mm long; stipules a persistent membranous interfoliar sheath; corolla mouth glabrous or papillose; styles retained in fruit, connate at their apices (sometimes separating post-maturity); south-western Australia ..... ***Adelphacme***
6: Leaves at least 10 mm long (except *M. sessilifolia* (J.F.Gmel.) G.Don ≥6 mm long and *M. petiolatoides* P.T.Li ≥5 mm long); stipules well-developed (mostly triangular) or reduced to a stipular line; corolla mouth with penicillate ring of hairs; styles not persisting in fruit or stigmas free, subsessile; Americas, Africa, Madagascar, Southeast and East Asia, New Guinea, northern Australia ..... ***Mitreola***
7. Placenta fleshy, yellow to red, with seeds embedded; Mascarene Islands, Malesia, north-eastern Australia and Pacific ..... ***Geniostoma***
7: Placenta dry, seeds not embedded; Australia (not Tasmania), doubtfully New Zealand (extinct) ... ***Logania***

[1] Species congeneric with *Schizacme* are currently recognised under the name *Mitrasacme* in New Zealand.

This key includes an optional modification to include the remaining Australian genus of Loganiaceae, *Strychnos* (Strychneae), by replacing couplet 7 with the following two couplets:

7. Fruit indehiscent, berry-like; leaves 3–7-plinerved ..... ***Strychnos***

7: Fruit a two-valved capsule; leaves penninerved..... 8

8. Placenta fleshy, yellow to red, with seeds embedded; Mascarene Islands, Malesia, north-eastern Australia and Pacific ..... ***Geniostoma***

8: Placenta dry, seeds not embedded; Australia (not Tasmania), doubtfully New Zealand (extinct).... ***Logania***

Discussion

Although we are, as yet, unable to identify a morphological synapomorphy for *Adelphacme*, the genus may be readily identified by a unique combination of morphological characters. In the molecular phylogeny of Gibbons et al. (2012), long branches separate *Mitrasacme*, *Schizacme*, *Phyllangium* and *Adelphacme minima*, further supporting their recognition as discrete genera, rather than as a more broadly defined *Mitrasacme*. Table 1 compares the morphological characteristics of *Adelphacme* with those of *Mitrasacme*, *Mitreola*, *Phyllangium* and *Schizacme*.

Adelphacme is distinguished from *Mitreola* by vegetative, floral and fruit characters. The stature and leaves of *Adelphacme* are much smaller than those of *Mitreola* and its stipules are reduced to a membranous, interfoliar sheath (*Mitreola* with stipules well-developed or reduced to a stipular line). These characters instead support the phylogenetic placement of *Adelphacme* sister to *Mitrasacme*, *Phyllangium* and *Schizacme*. The incompletely dichasial inflorescences of *Adelphacme* (refer Conn 1996; Fig. 1) are similar to those of *Mitreola* but do not extend into a long cincinnate distal portion, as is characteristic of most species of *Mitreola*. *Adelphacme* differs from *Mitreola* in its calyx without a distinct tube (*Mitreola* calyx lobes and tube ± equal). The corolla of *Adelphacme* is only slightly urceolate, with rounded lobes (*Mitreola* corolla distinctly urceolate, lobes generally subacute) and lacks the penicillate or pilose ring of hairs found in the corolla mouth of *Mitreola* (Leeuwenberg 1974). Corolla aestivation is valvate in *Adelphacme* but is generally quincuncial in *Mitreola*, with the exception of the Madagascan endemic *M. turgida* Jovet (Conn 1996). The stamens of *Adelphacme* are apiculate (by extension of the connective), as are those of *Schizacme* and of many species of *Mitrasacme* and *Phyllangium*. In *Mitreola petiolata* and *M. sessilifolia* the anthers appear apiculate but this character is uncertain in the remaining species of *Mitreola* because material was not available for examination. Leeuwenberg (1974, p. 4) states the anthers of *Mitreola* are "apiculate to retuse" but does not include this character in species descriptions. The gynoecium of *Adelphacme* is similar to that of *Mitreola*, except that the styles of *Mitreola* are generally shorter. However, in fruit, the styles of *Adelphacme* are persistent and remain united at their apices as the horns of the capsule separate, whereas in *Mitreola*, the styles separate soon after anthesis, and do not generally persist into fruit. The seeds of *Adelphacme* are smooth, ellipsoid, with a longitudinal groove on the ventral surface. This type of seed occurs in most species of *Mitreola* and in some species of *Mitrasacme*.

The habit, corolla and capsule of *Adelphacme* bear a strong resemblance to *Mitrasacme*. However, *Adelphacme* differs from *Mitrasacme* in its crowded uniflorescences (*Mitrasacme* uniflorescences generally lax), its almost free calyx lobes and its slightly semi-inferior ovary (*Mitrasacme* calyx lobes and tube ± equal and ovary superior). *Adelphacme* further differs from *Mitrasacme*, *Phyllangium* and *Schizacme* by its 5-merous calyx, corolla and androecium (4-merous in *Mitrasacme*, *Phyllangium* and *Schizacme*). *Adelphacme* resembles *Phyllangium* in its semi-inferior ovary. *Phyllangium* is distinguished from all other genera in Loganiaceae by its two-lobed involucral bract surrounding the flower and capsule and absent calyx (Dunlop 1996b). *Adelphacme* differs from *Schizacme* in having two styles united at the apex at anthesis and in fruit (*Schizacme* with styles free). The calyx of *Schizacme* is generally heteromorphic (Dunlop 1996c), with the exception of *S. montana* (Hook.*f.* ex Benth.) Dunlop, which occasionally has equal calyx lobes similar to those of *Adelphacme*. *Schizacme* is best distinguished from all other genera in Loganieae by its laterally compressed, cupuliform capsules (appearing broadly cuneiform in lateral view) and elongated, few-seeded placentation (Dunlop 1996c).

Capsule dehiscence in Loganieae

In *Adelphacme*, *Mitrasacme*, *Schizacme* and *Phyllangium*, dehiscence occurs along the ventral suture of the horns of the capsule, and not loculicidally as previously stated (Leeuwenberg & Leenhouts 1980; Dunlop 1996a, c, b; Gibbons et al. 2012). Confusion arises from alternative definitions of loculicidal in the literature.

Table 1. Morphological features diagnostic for *Adelphacme, Mitrasacme, Mitreola, Phyllangium* and *Schizacme*.

	Adelphacme	*Mitrasacme*	*Mitreola*	*Phyllangium*	*Schizacme*
Leaves	2.7–3.3 mm long, sessile	1–90 mm long, generally sessile	5–150 mm long, generally petiolate	2–13 mm long, sessile	2–14 mm long, sessile or subsessile
Stipules	persistent, membranous, interfoliar sheath	persistent, membranous, interfoliar sheath	persistent or reduced to a stipular line, well-developed triangular, ligulate or ochreate	persistent, membranous, interfoliar sheath	persistent, membranous, interfoliar sheath
Inflorescence	incompletely dichasial, uniflorescences crowded	variously cymose, generally lax, or flowers solitary	incompletely dichasial, generally becoming cinncinate distally, generally crowded	lax cymose, or flowers solitary	flowers solitary
Flowers	5-merous	4-merous	5-merous	4-merous	4-merous
Calyx	tube indistinct, lobes equal	tube distinct, lobes equal	tube distinct, lobes equal	absent, replaced by a two-lobed foliaceous involucre	tube indistinct, lobes usually heteromorphic
Corolla					
aestivation	valvate	valvate	generally quincuncial (valvate in *M.turgida*)	valvate	valvate or imbricate
ornamentation at mouth	glabrous or papillose	penicillate, pilose, papillose or glabrous	penicillate or pilose	glabrous	glabrous, pilose or papillose
Ovary	semi-inferior	superior	semi-inferior	semi-inferior	superior
Styles					
at anthesis	united	generally united (free in *M. secedens)*	united	united or free	free
in fruit	persistent, remaining united apically as horns separate	persistent, generally united apically (free in *M. secedens)*	separating soon after anthesis, not persistent or stigmas subsessile	united or free, sometimes withering in fruit	free, sometimes withering in fruit
Capsule	± globular, two horned	generally globular, ovoid ellipsoid or obovate, two horned	ellipsoid or ovoid, two-horned or bilobed	ellipsoid to obovate, two-horned (horns not well developed)	laterally flattened, horns widely divergent (appearing broadly cuneiform in lateral view)
Placentation	axile, hemispherical, seeds many	axile, hemispherical, seeds many	axile, hemispherical, seeds many	axile, hemispherical, seeds many	axile-apical, elongate, seeds 2–3 per locule

In some texts, loculicidal is defined as "longitudinal dehiscence radially aligned with the locules" (Simpson 2006, p. 562). However, loculicidal dehiscence is more accurately described as longitudinal dehiscence along the dorsal rib of the carpels, or (less frequently) between the dorsal rib and the septum (Spjut 1994, Beentje 2010). In completely syncarpous capsules, these definitions are equivalent. In semi-apocarpous capsules, dehiscence along the ventral suture of the horns, although perpendicular to the septum, is most correctly considered a form of septicidal dehiscence, the ventral aspect of the horns being continuous with the septum. In *Mitreola*, the degree of fusion of the carpels is variable, so that in some species the capsule first dehisces along the septum, although never to the base of the capsule, before dehiscing along the ventral suture. In *Logania* and *Geniostoma*, capsules appear completely syncarpous and styles generally appear single. However, in some species of *Logania*, there appear to be two styles connate along their length, with the stigma bilobed. Additionally, the septicidal capsules of *Logania* initially dehisce only on their distal half, and although the persistent valves subsequently separate along the septum to the base, dehiscence along the ventral suture remains confined to the distal half of the valves (Conn & Brown 1996). These observations suggest the syncarpous capsules of *Logania* are secondarily derived, supporting the hypothesis of Backlund et al. (2000) that semi-apocarpy provides a morphological synapomorphy for Loganieae.

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